

What is claimed is:

1. A planar waveguide device comprising a substrate defining a first microchannel and having a first waveguide composed of a core and a cladding, wherein a first portion of the microchannel is positioned in sufficient proximity to a first portion of the core of the waveguide that an amount of optical power from an optical signal traversing the waveguide extends into said portion of the microchannel positioned in proximity to said portion of the core, wherein the microchannel is a continuous microchannel in which a fluid can circulate, and wherein the microchannel is formed in the substrate.

2. An optical device comprising a substrate defining a first microchannel and having a first waveguide composed of a core and a cladding, wherein a first portion of the microchannel is positioned in sufficient proximity to a first portion of the core of the waveguide that an amount of optical power from an optical signal traversing the waveguide extends into the microchannel, wherein the microchannel contains at least a first fluid and a second fluid, and wherein the first fluid and the second fluid have physical properties such that the first fluid and the second fluid move under at least one force selected from the group consisting of electrocapillarity, differential-pressure electrocapillarity, electrowetting, electrophoresis, electroosmosis, dielectrophoresis, electrohydrodynamic pumping, magnetohydrodynamic pumping, thermal expansion, dielectric pumping, and variable dielectric pumping.

3. A device according to claim 2 wherein the first fluid and the second fluid have physical properties such that the first fluid and the second fluid move under at least one force selected from the group consisting of differential-pressure electrocapillarity, electrophoresis, electroosmosis, dielectrophoresis, electrohydrodynamic pumping, magnetohydrodynamic pumping, and variable dielectric pumping.

4. A planar waveguide device comprising a substrate defining a first microchannel and having at least two electrodes in communication with the microchannel and a first waveguide composed of a core and a cladding, wherein a first portion of the microchannel is positioned in sufficient proximity to a first portion of the core that an amount of optical power from an optical signal traversing the waveguide extends into the portion of the microchannel in proximity to the portion of the core; and wherein the

microchannel contains at least a first material having optical properties, a first fluid, and a second fluid, the first fluid and the second fluid having physical properties such that the first fluid and the second fluid move said first optical material toward or away from the core when a voltage is applied to the electrodes.

5. A planar waveguide device comprising a substrate defining a first microchannel and having at least one heater in heat exchange relationship with the microchannel and a first waveguide composed of a core and a cladding, wherein a first portion of the microchannel is positioned in sufficient proximity to a first portion of the core that an amount of optical power from an optical signal traversing the waveguide extends into the first portion of the microchannel; wherein the microchannel contains at least a first material having optical properties and a first fluid having physical properties such that the first fluid moves the first material toward or away from the core when the heater is actuated; and wherein the heater is positioned sufficiently far from the first material that the optical properties of the first material are unaffected when the heater is actuated.

6. An optical device comprising a substrate defining a first microchannel and having a first waveguide composed of a core and a cladding, wherein a first portion of the microchannel is positioned in sufficient proximity to a first portion of the core of the waveguide that an amount of optical power from an optical signal traversing the waveguide extends into the microchannel, wherein the microchannel contains at least a first fluid and a first optical material, wherein the first fluid has physical properties that move the first optical material within the first fluid upon application of energy to the first fluid, and wherein the first optical material has physical properties such that the first optical material refracts, diffracts, scatters, absorbs, or phase shifts an amount of the optical signal passing through the first optical material.

7. A device according to claim 4 or claim 6 wherein the first optical material is a solid.

8. A device according to claim 4 or claim 6 wherein the first optical material is a suspension.

9. An optical device comprising a substrate defining a first microchannel and having a first waveguide composed of a core and a cladding, wherein a first portion of the

microchannel is positioned in sufficient proximity to a first portion of the core of the waveguide that an amount of optical power from an optical signal traversing the waveguide extends into the microchannel, wherein the microchannel contains at least a first fluid and a first optical material, wherein the first fluid has physical properties that move the first optical material within the first fluid upon application of a force to the first fluid, said force being selected from electrocapillarity, differential-pressure electrocapillarity, electrowetting, electrophoresis, electroosmosis, dielectrophoresis, electrohydrodynamic pumping, magnetohydrodynamic pumping, thermal expansion, dielectric pumping, and variable dielectric pumping, and wherein the first optical material has physical properties such that the first optical material reflects an amount of the optical signal encountering the first optical material.

10. A device according to claim 9 wherein the first fluid has physical properties that move the first optical material within the first fluid upon application of a force to the first fluid, said force being selected from differential-pressure electrocapillarity, electrophoresis, electroosmosis, dielectrophoresis, electrohydrodynamic pumping, magnetohydrodynamic pumping, and variable dielectric pumping.

11. A device according to any of claims 1 and 4 and further comprising a second waveguide having a second core, a first portion of the second core being in sufficient proximity to the first waveguide that at least a portion of the optical power from the optical signal traversing the first waveguide couples into the second waveguide.

12. A device according to claim 11 wherein a second portion of the microchannel is in sufficient proximity to the first portion of the second core that an amount of optical power from an optical signal traversing the second waveguide extends into said second portion of the microchannel.

13. A device according to claim 11 wherein the first portion of the microchannel in proximity to the first core is also in sufficient proximity to the second core that an amount of optical power from an optical signal traversing the second waveguide extends into the first portion of the microchannel.

14. A device according to claim 11 wherein the device further comprises a second microchannel, a first portion of the second microchannel being in sufficient

proximity to the first portion of the second core that an amount of optical power from an optical signal traversing the second waveguide extends into said first portion of the second microchannel.

15. A device according to claim 14 wherein the second microchannel is a discontinuous microchannel having a first end and a second end.

16. A device according to claim 15 wherein the second microchannel contains a fluid identical to one of said fluids in the first microchannel and the second microchannel has dimension about equal to dimensions of the first portion of the first microchannel such that temperature sensitivity of the device is reduced compared to an identical device that does not have the second microchannel.

17. A device according to claim 14 wherein the second microchannel is a continuous microchannel.

18. A device according to claim 17 wherein the second microchannel contains a first optical material and a first fluid, the first optical material being movable to and from the first portion of the second microchannel by application of electricity or heat.

19. A device according to any of claims 1 and 4 wherein the first waveguide is configured such that the optical signal is multimode as the optical signal traverses the portion of the first core positioned in sufficient proximity to the first portion of the first microchannel that said amount of optical power extends into the first portion of the first microchannel.

20. A device according to claim 19 wherein the device comprises a second microchannel having a first portion in sufficient proximity to the first core that a portion of said optical power extends into the first portion of the second microchannel.

21. A device according to claim 20 wherein the second microchannel is a continuous microchannel.

22. A device according to claim 19 wherein the optical device is a multimode interference filter having a first exit waveguide and a second exit waveguide coupled to said first waveguide.

23. A device according to any of claims 1 and 4 wherein the device is configured to separate different optical modes of the optical signal.

24. A device according to claim 23 wherein said first waveguide forms a portion of a first exit waveguide from the device, wherein the device further comprises a first entrance waveguide, a second entrance waveguide, and a second exit waveguide in optical communication with a multimode interference waveguide, wherein the first entrance waveguide and the second entrance waveguide are of unequal width, wherein the first exit waveguide and the second exit waveguide are of equal width, and wherein a second portion of the first microchannel is also positioned in sufficient proximity to a portion of said second exit waveguide that an amount of said optical power extends into said second portion of the first microchannel.

25. A device according to claim 24 wherein said first portion of the first microchannel is positioned adjacent to the first exit waveguide in sufficient proximity that a portion of power of the optical signal entering the first exit waveguide extends into the first portion of the first microchannel and said second portion of the first microchannel is positioned adjacent to the second exit waveguide in sufficient proximity that a portion of power of the optical signal entering the second exit waveguide extends into the second portion of the first microchannel.

26. A device according to any of claims 1 and 4 wherein the device is configured to effect an interference of the optical signal.

27. A device according to claim 26 wherein the device comprises a Mach-Zehnder interferometer.

28. A device according to claim 26 wherein the device comprises a multimode interference filter.

29. A device according to any of claims 1 and 4 wherein the device is configured to leak at least a portion of the optical signal from the core.

30. A device according to claim 29 wherein said first microchannel forms a portion of the cladding and not the core of the device.

31. A device according to claim 4 wherein the first microchannel is a continuous microchannel in which a fluid may circulate.

32. A device according to claim 4 wherein the first microchannel is a discontinuous microchannel having a first end and a second end.

33. A device according to claim 32 wherein the first fluid is a liquid and the first end of the first microchannel is in communication with a first reservoir containing a compressible gas.

34. A device according to claim 33 wherein the second end of the microchannel is in communication with a second reservoir containing the compressible gas.

35. A device according to claim 34 wherein the first and second reservoirs are in fluid communication such that said compressible gas moves between the first and second reservoirs as the liquid moves in the first microchannel.

36. A device according to any of claims 1 and 4 wherein the first portion of the first microchannel supplants said portion of the core of the first waveguide.

37. A device according to claim 36 wherein the first portion of the first microchannel supplants a sufficient amount of said core that said core is bisected by the first portion of the microchannel.

38. A device according to claim 1 and 4 wherein the first portion of the first microchannel does not supplant said portion of the core of the first waveguide.

39. A device according to claim 38 wherein the first portion of the first microchannel is immediately adjacent to said portion of the core of the first waveguide.

40. A device according to claim 38 wherein the first portion of the first microchannel is adjacent to and separated from said portion of the core of the first waveguide by a portion of the cladding.

41. A device according to claim 39 wherein said first portion of the core of the first waveguide is rib-shaped and wherein said first portion of the first microchannel is adjacent to one face of the rib.

42. A device according to claim 39 wherein said first portion of the core of the first waveguide is rib-shaped and wherein said first portion of the first microchannel is adjacent to three faces of the rib.

43. A device according to any of claims 1 and 4 wherein the first portion of the microchannel has a first cross-sectional area, and a second portion of the microchannel away from the first waveguide has a second cross-sectional area greater than the first cross-sectional area.

44. A device according to any of claims 1 and 4 wherein the first portion of the microchannel has a first cross-sectional area, and a second portion of the microchannel away from the first waveguide has a second cross-sectional area smaller than the first cross-sectional area.

45. A device according to claim 43 wherein the microchannel contains a first optical material in or near the first portion of the microchannel and the microchannel contains a first fluid and a second fluid in a second portion of the microchannel, the first and second fluids having physical properties such that an interface between the first fluid and the second fluid moves as heat is applied to at least the first fluid or electricity is applied to the first and second fluids to thereby move the first optical material out of or into the first portion of the microchannel.

46. A device according to any of claims 1 and 4 wherein the first portion of the microchannel has a portion of a surface defining the microchannel modified to provide a force to the first optical material when an interface between the first optical material and the first fluid encounters said portion of the surface.

47. A device according to claim 4 wherein the first optical material comprises a fluid selected for one or more of its refractive, diffractive, dispersive, absorptive, and reflective properties.

48. A device according to claim 4 wherein the first optical material is a solid.

49. A device according to any of claims 1 and 4 wherein the device is configured as an evanescent coupler or a Mach Zehnder interferometer.

50. A device according to any of claims 1 and 4 wherein the device is configured as an optical shutter, a switch, an attenuator, a branching waveguide switch, a reflection switch, a total internal reflection switch, or a multiplexer.

51. A device according to claim 4 wherein said device contains at least two immiscible fluids.

52. A method of making a planar waveguide device comprising forming an open-faced continuous microchannel in sufficient proximity to a core of a waveguide that at least a portion of optical power from an optical signal passing through the waveguide extends into the microchannel, placing at least a first and a second fluid into the microchannel such that a first interface between the first and second fluids is movable by

an external force such that an amount of the first fluid in proximity to the core is displaced by the second fluid as the first interface moves, and placing a lid over the open-faced continuous microchannel and attaching the lid to the face of the substrate.

53. A method according to claim 52 wherein said microchannel is formed at least partially in said lid.

54. A method according to claim 52 wherein said microchannel is formed in the substrate.

55. A method according to claim 52 wherein the act of placing the first and the second fluids into the microchannel is performed after attaching the lid to the face of the substrate through through-holes in said lid or in said substrate.

56. A method according to claim 52 wherein said method further comprises forming electrodes at said microchannel which provide said external force.

57. A method according to claim 56 wherein at least one of said electrodes is formed on said lid.

58. A method of making a planar waveguide device comprising forming a microchannel in sufficient proximity to a core of a waveguide that at least a portion of optical power from an optical signal passing through the waveguide extends into the microchannel, and placing at least a first, a second, and a third fluid into the microchannel such that a first interface between the first and second fluids is movable by an external force applied to an interface between the second and third fluids such that an amount of the first fluid in proximity to the core is displaced by the second fluid as the first interface moves.

59. A method according to claim 58 wherein said method further comprises forming electrodes at said microchannel which provide said external force.

60. A method of making a planar waveguide device comprising forming a microchannel in sufficient proximity to a core of a waveguide that at least a portion of optical power from an optical signal passing through the waveguide extends into the microchannel, placing a plurality of fluids comprising at least a first and a second fluid into the microchannel such that a first interface between the first and second fluids is movable by an external force applied to a second fluid interface such that an amount of the first fluid in proximity to the core is displaced by the second fluid as the first interface



moves, and providing electrodes in sufficient proximity to the second fluid interface that the interface is movable using a force selected from at least one force selected from the group consisting of differential-pressure electrocapillarity, electrophoresis, electroosmosis, dielectrophoresis, electrohydrodynamic pumping, magnetohydrodynamic pumping, dielectric pumping, and variable dielectric pumping.

61. A method according to claim 52 wherein said microchannel is formed by removing at least a portion of the core of the waveguide.

62. A method according to claim 52 wherein said microchannel is formed by removing said cladding to a surface of the core.

63. A method according to claim 52 wherein said microchannel is formed by removing said cladding to a distance from the core leaving cladding between the microchannel and the core.

64. A method according to claim 52 wherein said device is hermetically sealed.

65. A method of transmitting an optical signal in a planar waveguide device comprising positioning a first optical fluid sufficiently near to a core of a waveguide of the device such that at least a portion of optical power from the optical signal passing through the waveguide extends into the first optical fluid.

66. A method of modifying an optical signal in a planar waveguide device comprising positioning a first optical fluid sufficiently near to a core of a waveguide of the device such that at least a portion of optical power from the optical signal passing through the waveguide extends into the first optical fluid and altering the optical signal by displacing at least a portion of the first optical fluid with a second optical fluid.